ASTR 565 Compact Objects

Syllabus, Spring 2014 — Lecturer: Matthew Baring

See `http://spacibm.rice.edu/%7Ebaring/astr565/astr565.html` for details.

1. Compact Object Overview

1. Compact Objects
   White Dwarfs
   Neutron Stars
   Black Holes

2. Compact Object Formation
   Population Statistics

2. Condensed Matter States

1. Thermodynamics and Kinetic Theory
   Kinetic Theory

2. Equations of State
   Degenerate, Ideal Fermi Gas: Chandrasekhar
   Electrostatic Corrections: Thomas-Fermi Atoms
      Thomas-Fermi Atomic Charge Distribution
   Ideal, Cold $n - p - e$ *Gas*

3. Nuclear Influences on the Equation of State
   Harrison-Wheeler EOS
   Baym-Pethick-Sutherland EOS

3. White Dwarf Stars

1. Hydrostatic Equilibrium
2. Polytropes: Lane-Emden Equation
3. The Chandrasekhar Mass Limit
4. Observations of the Mass-Radius Relation
5. Improvements to Chandrasekhar Models
6. Pyconuclear Reactions

4. White Dwarf Cooling

1. Surface Layer Stucture
2. White Dwarf Cooling
3. Crystallization and Melting Temperature
4. Heat Capacity of the Coulomb Lattice

5. General Relativity

1. Introductory General Relativity
2. Schwarzschild Metric
3. Oppenheimer-Volkoff Equation

6. White Dwarf Stability And Rotation

1. White Dwarf Stability
2. Magnetic Fields and the Virial Theorem
   Magnetic White Dwarfs
3. Rotating White Dwarfs
   Rotating, Spherical Stars
   Maclaurin Spheriods
   Spheroidal Modifications to White Dwarf Stability

7. Neutron Star Interiors

1. Equations of State Beyond Neutron Drip
2. Bethe-Baym-Pethick Equation of State
3. Modeling Nuclear Saturation
   Yukawa Potentials
4. Bethe-Johnson Equation of State
5. Ideal Gas EOS in the Nuclear Domain
6. Observations of Neutron Star Masses
7. The Maximum Mass
8. Onset of Instability in Density Space
9. General Relativistic Stability Analysis

8. Pulsars And Magnetars

1. Pulsars as Rotating Neutron Stars
   Are They Really Neutron Stars?
2. Radio Pulsar Observations
   Pulse Dispersion
3. Pulsar Spin-Down
4. High Energy Pulsar Emission Mechanisms
5. Magnetar Theory
   Quasi-Periodic Oscillation Seismology

9. Neutron Star Cooling

1. Neutrino Reactions in Neutrino Stars
2. The Plethora of Neutrino Generators
3. Neutrino Transparency
4. Observations and Diagnostics
   Probes of the Nuclear Equation of State

10. Black Holes And Gravitational Waves

1. The Black Hole Concept
2. Test Particle Motions in Schwarzschild Geometry
3. Photon Orbits in the Schwarzschild Metric
4. Kerr Black Holes
5. Hawking Radiation
6. Gravitational Radiation
7. Binary Pulsars

11. Accretion In Compact Objects

1. Observational Overview
2. Bondi Accretion
3. Accretion in Close Binaries
   Flare Emission from Galactic Black Holes

12. Relativistic Jet Sources

1. Microquasars
2. Blazars and Supermassive Black Holes
   Constraining Black Hole Spin
3. Gamma-Ray Bursts
4. The Crab Pulsar Wind